What is claimed is:

1. A hard disk drive based data archive system emulating a tape archive system and comprising:

5   a hot pluggable multi-drive magazine comprising a housing and a plurality of hard disk drives installed within the housing, each drive upon installation being connected to receive power and data from the magazine in a controlled fashion, and

a magazine receiving system for physically receiving the magazine

10   and for providing power and data connections to the magazine, such that when the magazine is received within the magazine receiving system, the hard disk drives selectively receive power and data connections with the magazine receiving system.

15   2.   The data archive system set forth in claim 1 further comprising a magazine controller for controlling application of power and data connections to each one of the plurality of hard disk drives installed in the magazine.

20   3. The data archive system set forth in claim 1 further comprising annunciation means associated with the magazine and operated by the magazine controller for annunciating predetermined conditions determined to be present in the magazine by the magazine controller.

4. The data archive system set forth in claim 3 wherein the annunciation means comprises a flashing visual indicator in which flash patterns provide said annunciation of predetermined conditions.

5. The data archive system set forth in claim 1 wherein the magazine housing provides shock protection to the hard disk drives installed therein.

6. The data archive system set forth in claim 1 wherein the magazine housing facilitates ventilation and cooling of the hard disk drives installed therein.

7. The data archive system set forth in claim 1 wherein the magazine receiving system is connected to a host computing system and is configured to provide power and data connections simultaneously to the plurality of hard disk drives.

8. The data archive system set forth in claim 1 wherein the magazine receiving system comprises an archival system remotely located from a host computing system in a secured environment, and is configured to provide power and data connections to a single hard disk drive of the magazine at a time.

9. A hot pluggable multi-drive magazine for a hard disk drive based data archive system emulating a tape archive system and comprising:

a housing defining a plurality of receptacles for receiving and securing a plurality of standard form factor hard disk drives,

an electrical interface structure within the housing for connecting

each drive upon installation to receive power and data in a controlled

fashion, and

magazine control and identification means associated with the multi-

5   drive magazine for controlling the electrical interface structure.

10.   The multi-drive magazine set forth in claim 9 wherein said

housing defines a plurality of substantially parallel receptacles that are

spaced apart and further defines an arrangement of air flow apertures

10   arranged to facilitate convective cooling air flow between adjacently facing

walls of hard disk drives secured within said receptacles.

11.   The multi-drive magazine set forth in claim 10 wherein the

magazine control and identification means comprises a controller embedded

15   within the magazine.

12.   The multi-drive magazine set forth in claim 9 wherein the

magazine control and identification means is part of a multi-magazine

receiver, and wherein the multi-drive magazine includes a unique identifier

20   readable by the magazine control and identification means when the multi-

drive magazine is installed in the multi-magazine receiver.

13. The multi-drive magazine set forth in claim 12 wherein the

unique identifier comprises a bar code pattern, and wherein the magazine

25   control and identification means includes bar code reader means for reading

the bar code pattern when the multi-drive magazine is installed in the multi-magazine receiver.

14. The multi-drive magazine set forth in claim 12 wherein the unique identifier comprises an internet protocol (IP) address within a TCP/IP network.

15. A data storage box for connection to a host computing system via a universal serial bus (USB) structure and comprising:

a housing structure defining a plurality of wells,

each well configured to receive and secure a hard disk drive unit implementing an ATA interface structure and connector,

a plurality of USB bridge circuits in the housing, each USB bridge circuit being associated with a said well and electrically connectable to the ATA interface connector of a hard disk drive unit upon installation in said well,

a USB hub circuit connected between a single USB connector present at an external face of the housing for connecting to said USB structure and the plurality of USB bridge circuits for routing control and data signals, and power up/power down signals through a said USB bridge circuit to control its said hard disk drive unit,

and

power connector means present at an external face of the housing structure for receiving operating power for said storage box.

16. A data storage box for connection to a host computing system via a plurality of universal serial bus (USB) structures and comprising:

a housing structure defining a plurality of wells,

each well configured to receive and secure a hard disk drive

5   unit implementing an ATA interface structure and connector,

a plurality of USB connectors present at an external face of the housing structure for connecting respectively to said plurality of USB structures,

a plurality of USB bridge circuits in the housing, each USB

10   bridge circuit being associated with a said well and electrically connectable to the ATA interface connector of a hard disk drive unit upon installation in said well and to one of said USB connectors,

and

power connector means present at an external face of the

15   housing structure for receiving operating power for said storage box.

17. A data storage box for connection to a host computing system via an internet network connection in accordance with the internet TCP/IP interface comprising:

20   a housing structure defining at least one well,

said well configured to receive and secure a hard disk drive unit having an IP interface address and having an interface connector,

and an interface connector present at an external face of the housing structure for connecting respectively to said TCP/IP interface.

25

18. The data storage box set forth in claim 17 wherein the hard disk

drive unit includes an Ethernet physical interface, and wherein the interface

connector comprises an Ethernet-compatible connector, and further

comprising power connector means present at an external face of the

5   housing structure for receiving operating power for said storage box.

19. The data storage box set forth in claim 17 wherein the housing

structure defines a plurality of wells, and further comprising a plurality of

hard disk drives, and a hub circuit for selectively connecting a said one of

10   said plurality of hard disk drives to said interface connector.

20. The data storage box set forth in claim 19 wherein the housing

structure has a unique IP interface address.

15   21. A hard disk drive data archive system for emulating electrically

a tape library including a multiplicity of tape cartridges each having a

predetermined storage capacity, the hard disk drive data archive system

comprising:

a hot pluggable multi-drive magazine comprising a housing and a

20   plurality of hard disk drives installed within the housing,

each hard disk drive upon installation being connected to receive

power and data from the magazine in a controlled fashion, and

each hard disk drive defining an electrical data storage capacity at

least equal to the predetermined storage capacity of a said tape cartridge

25   being emulated.

22. The hard disk drive data archive system set forth in claim 21 further comprising a magazine receiving system connected to a host data processing system and for physically receiving the magazine and thereupon providing power and data connections to the magazine, such that when the magazine is received within the magazine receiving system, the hard disk drives selectively receive power and data connections with the magazine receiving system, and

archive system control means associated with the magazine receiving system for enabling virtual loading and unloading of said hard disk drives in response to host data processing system commands issued to load and unload tape cartridges being emulated.

23. The hard disk drive data archive system set forth in claim 21 wherein a said hard disk drive implements a tape file mark structure in hard disk logical block address space as a double linked list heuristic including pointers to a last file marker and a next file marker.

24. The hard disk drive data archive system set forth in claim 23 wherein each file mark structure occupies a separate sector in logical block address space of said drive.

25. A method for archiving user data within an active data processing system comprising steps of:

A. transferring said user data to be archived to a hard disk archive array comprising at least one hot pluggable multi-drive magazine having a housing and a plurality of hard disk drives installed within the housing,

each hard disk drive upon installation being connected to receive power and data from the magazine in a controlled fashion; and, a magazine receiving system connected to the active data processing system for physically receiving the magazine and thereupon providing power and data

5   connections to the magazine, such that when the magazine is received within the magazine receiving system, the hard disk drives selectively receive power and data connections with the magazine receiving system,

B. removing the magazine from the magazine receiving system connected to the active data processing system following completion of

10 transfer of user data to be archived,

C. installing the magazine in a data preservation vault in a secure location remote from a location of the active data processing system, and,

D. periodically and selectively applying power to each one of the hard disk drives installed within the magazine in the data preservation vault

15 during a drive testing interval, and carrying out drive performance checks upon a said drive during the drive testing interval.

26. The archiving method set forth in claim 25 wherein the step (D) includes a step of read-verifying archived data stored on the said one of the

20 hard disk drives being performance checked.

27. The archiving method set forth in claim 26 wherein the step of read-verifying archived data stored on the said one of the hard disk drives is carried out by the archive magazine receiving system by using a limited

25 bandwidth data and control connection with said drive.

28. The archiving method set forth in claim 27 wherein the step of read-verifying archived data stored on the said one of the hard disk drives is carried out by sending control signals to said drive from an archive computer associated with the archive magazine receiving system and

5   receiving status and user data from said drive at said archive computer.

29. The archiving method set forth in claim 28 wherein the archive computer has a network connection to an active data processing system and comprising further steps of receiving an archived user data file retrieval

10   request from the active data processing system via the network connection, retrieving the archived user data file from at least one of the hard disk drives of a magazine installed in the archive magazine receiving system and sending the retrieved archived user data file to the active data processing system via the network connection.

15

30.   The archiving method set forth in claim 25 being adapted to emulate a cartridge tape library and including the step of assigning each said hard disk drive to emulate a tape cartridge of said cartridge tape library.

20   31. The archiving method set forth in claim 30 wherein the step of assigning each hard disk drive to emulate a tape cartridge is carried out by associating a said hard disk drive with a single tape cartridge of the cartridge tape library.

25   32. The archiving method set forth in claim 30 including a further step of implementing a tape file mark structure in logical block address

space of a said hard disk drive as a double-linked-list heuristic including pointers to a last file marker and a next file marker.

33. The archiving method set forth in claim 32 wherein the step of implementing a tape file mark comprises the step of recording each file mark structure within a separate sector in logical block address space of said drive.

34. A method for testing data-archive functionality of a rotating hard disk drive holding user archive data within an archive array of rotating hard disk drives, comprising the steps of:

A. measuring a time-off interval of the rotating hard disk drive with an interval timer;

B. at an end of a measured time-off interval, selectively applying operating power to the rotating hard disk drive for a fixed operational interval;

C. during the fixed operational interval, checking the rotating hard disk drive to determine that it is functional as an archival data storage medium;

D. if the rotating hard disk drive is determined to be functional, selectively removing operating power to said drive and resetting the interval timer to begin measuring a next time-off interval for said drive; and,

E. If the rotating hard disk drive is determined to be non-functional, selectively removing operating power to said drive, and setting an error flag associated with said drive to signal non-functionality of said drive.

35. The testing method set forth in claim 34 comprising a further step:

F. if the rotating hard disk drive is determined to be functionally degraded below predetermined minimum criteria but currently operational, transferring the archive user data held by said drive to a spare rotating hard disk drive of said array, selectively removing power from said rotating hard disk drive determined to be functionally degraded, and setting an error flag associated with said drive.